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(12) # EUROPEAN PATENT APPLICATION

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(54) **Method of manufacturing a foundation.**

(57) Expanding material is placed in the ground, as a result of which both the ground and the expanding concrete are placed under compression.

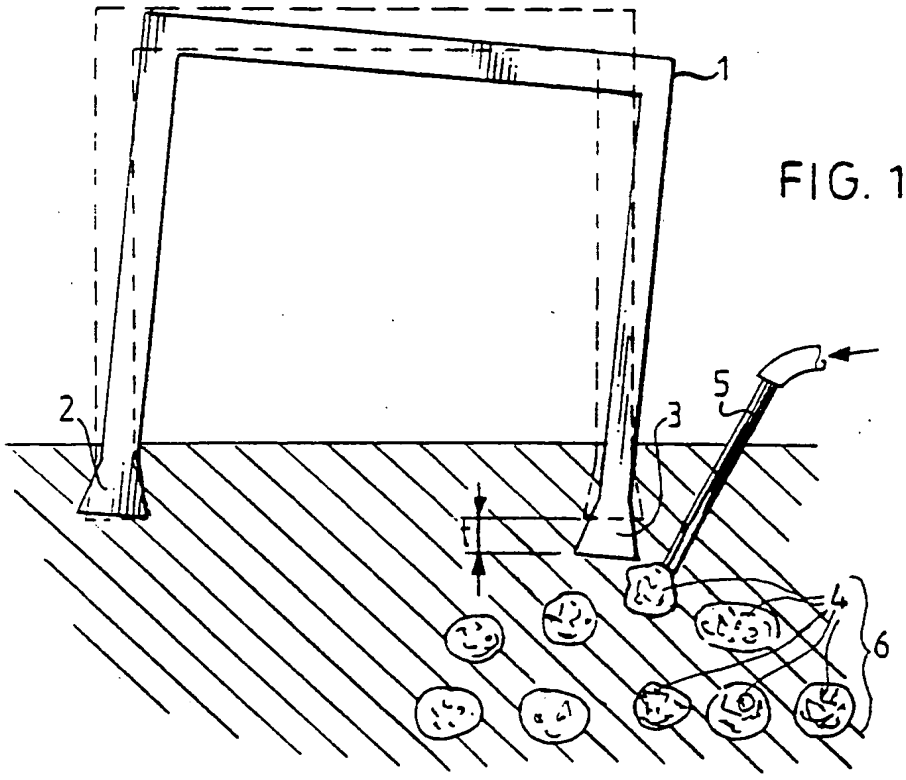

FIG. 1

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Method for manufacturing a foundation.

The invention relates to a method for manufacturing a foundation, whereby expanding material is placed in the ground.

Such a method is known from the American patent 3.504.497. In this method proposed in 1966 an expanding material is employed which in the case of free expansion has a maximum of 4.4% linear expansion. Added to the concrete mortar for this purpose is 33.6% calcium sulpho-aluminate cement which is a component causing expansion. This results in a driven concrete pile cast in the ground having a considerably greater bearing capacity.

The invention has for its object to provide an improved foundation. To this end the feature of claim 1 is applied. Expanding concrete is particularly suitable as expanding material, for example a mixture of sand, gravel, water, cement with an additive substance of calcium sulpho-aluminate for the forming of ettringite and/or magnesium oxide MgO for the purpose of hydration.

Calcium sulpho-aluminate is an additive substance for the realizing of concrete expansion or for compensating concrete shrink per se known as C.S.A., which is brought on the market under the brand name Dilacon by the Italian firm Enichem Anic of Milan. This additive which has a very strong expanding action compared to calcium sulpho-aluminate cement, is added in very small quantity to concrete mortar, as an overdose can cause the concrete to burst apart. Contrary hereto in accordance with the invention, much of this C.S.A. is added to concrete mortar that is to be placed in the ground, taking into account the fact that during setting the concrete in the ground undergoes expansion which displaces the surrounding earth and therefore imposes a compression on the ground. The reaction compression applied by the ground to the concrete holds the concrete under compression, which prevents the concrete bursting apart.

Situations are conceivable where the earth is so loose that the pressure build-up caused is small. The concrete mortar with a considerable dose of C.S.A. will then expand very strongly and could burst apart. In this use of the invention even loose ground is still placed under pressure to some extent owing to the great extent of forced displacement, while the concrete which has burst into pieces still has a per se greater ridigity than the surrounding earth and thus functions very well in this position as foundation material.

Conceivable here is the injecting of concrete mortar with much C.S.A. into loose ground under buildings which have the tendency to subside. This can be carried out easily at any random level, even beneath an already existing foundation element and an already existing building structure which has settled out of level, without damaging the building and/or adjacent buildings and without causing much inconvenience. The method according to the invention is therefore eminently suitable for renovation of old town and city centres. In order to increase the bearing capacity of a foundation pile, expanding material can first be placed in the ground and the foundation pile can then be inserted into the ground onto the expanding material. Thus created is a broad pile foot, as it were, which is rigidly anchored in the ground. A foundation pile with foot can if required be manufactured from one piece of expanding material, for example expanding concrete. Brought about in this case is not only a foot that is well anchored in solid ground, but also a substantial adhering of the pile to the often somewhat looser ground located at higher levels.

The invention will be elucidated in the description following hereinafter with reference to a drawing.

In the drawing in diagrammatic form:

Fig. 1, 2, 3 and 4 show respectively a building which has settled out of level, a pile foundation, a road and a railway, whereby the invention is applied,

fig. 5-8 each show another method according to the invention in successive steps, and

fig. 9 and 10 constructions with a foundation according to the invention, whereby tie members are used as foundation elements.

In accordance with fig. 1 a building structure 1 drawn with full lines which has settled out of level and which rests on foundation elements 2 and 3 is moved into the position drawn in dashed lines by injecting expanding material 4 into the ground via an injecting pipe 5 so that it is distributed through the ground in different places under foundation element 3. The quantity and type of expanding material is thereby chosen such that the building structure rises the required measure t at that location. Should the required lifting measure t not be achieved initially, then a further quantity of expanding material can be injected into the soil beneath the body of earth 6 of the ground improved with the expanding material 4, in order to carry out the desired correction.

It is noted that it is not always necessary for an old building structure to be set entirely straight. It can in particular circumstances be preferable to preserve a certain measure of tilt. It is even conceivable that only so little expanding material is injected that the building structure all but maintains its position and that the injection aims to prevent further subsidence. It is also conceivable in the case of a wholly subsided building

to apply the necessary foundation of expanding material around it, that is, by injection of expanding material under the entire edge foundation of the building structure. Thus is created a broad pile foot 29 having around it a zone 31 of compressed earth, that is, earth with bearing strength (see fig. 7b), which forms part of an improved body of earth, that is, a body of earth into which expanding material has been injected. As a result of the swelling of the expanding material the surrounding earth is put under pressure, which causes the bearing capacity of this earth to increase. While in fig. 1 the body of earth 6 is manufactured according to the invention underneath a ridge-like foundation element 3 of an already existing building structure 1 it is also conceivable to manufacture a similar body of earth 6 under foundation piles 33 of a building structure 34 (fig. 2), under a road surface 35 (fig. 3) or under a railway track 36 (fig. 4) in the case where local subsidences have to be corrected.

As according to fig. 5a a hollow 10 is formed in the ground through a layer of loose soil 11 into a more stable layer of earth 12. To this end a pipe 7 with a separate bottom cover 8 is driven into the ground as according to fig. 5a. While pipe 7 is being withdrawn, leaving the cover 8 behind in the ground, expanding material 13, for instance setting concrete with additive, is then poured into the lower end of hollow 10 at the point of ground layer 12, which material expands from the configuration drawn in dashed lines into that drawn with full lines. Above this a concrete foundation pile 14 of normal concrete is subsequently formed by casting concrete mass into the hole 10. This results in the configuration of fig. 5b.

As according to fig. 6a a concrete pile is manufactured in the ground by means of an auger drill or bucket excavator. Expanding material 18 is thereby applied over the whole length of the bore hole 10, so that there results finally as according to fig. 6b a thicker foundation pile 19 of hardened expanding material which has a good sticking adhesion to the surrounding loose earth 11 which is under pressure, while the pile foot 20 rests on stable ground 12.

In accordance with fig. 7a expanding material 24 is injected via an injecting pipe 25 through the loose earth layer 11 into the more stable ground layer 12. A pile 27 is then driven into the ground as according to fig. 7b into the mass of expanding material 24 placed in the ground beforehand and not yet hardened.

As in fig. 8a a foundation pile 60 is first placed into the ground 61, this foundation pile 60 being provided with an injecting pipe 62 and on its bottom with a sack 64 of rubber or plastic. Expanding material 63 is subsequently injected as according to fig. 8b via pipe 62, which results in a foundation pile foot 66 in the inflated sack 64 standing in compressed earth 67.

In accordance with fig. 9 an earth barrier 40 is supported by means of a tie member 41 consisting of a steel profile, for example tubing or I-profile with an anchor 42 at its end, this tie member being located inclining downward in a parcel of earth 43. This tie member 41 can be accommodated in a bore hole 44 that is filled with expanding material 45. The tensioning capacity of this tie member 41 is considerably enlarged, since it is situated in surrounding earth that is compressed.

According to fig. 10 a swimming bath 50 is anchored in loose earth 55 by means of vertical tie rods 52, the bottom ends of which are located in solid ground 53, where they are encased with expanding material 45. This anchoring prevents the empty swimming bath rising up in the loose earth 55.

It is remarked that expanding concrete is per se known in the manufacture of surface concrete constructions. An addition substance of 20-60 kg. of calcium sulpho-aluminate is thereby added to a 1 cubic metre mix of sand, gravel, water and cement. The free linear expansion thereby realised amounts to 0.1-1.0%. The purpose of this swelling is to prevent crack forming as a consequence of shrink and expansion stresses. As a result of the swelling the reinforcement is tensioned slightly, which results in a certain pre-stressing which resists concrete cracking. In short, the known use of expanding concrete with C.S.A. has the purpose of preventing cracks in concrete, or in other words to improve the condition of the concrete. Proposed in accordance with the current invention is the use of a dose of C.S.A. additive of at least 70, and preferably 100-200 kg/m^3, which results in the concrete expansion being considerable, that is, at least 1%, and preferably 2-8%, linear expansion in the compressed ground. The addition is dosed such that a like addition in concrete with free expansion potential would result in bad concrete. As the concrete in the ground is enclosed on all sides by earth, the concrete itself is subjected to compression. As a result, even with this considerable additive dosage, the condition of the concrete is nevertheless good. In solid ground a linear expansion of 1% could be sufficient to place this ground under compression such that the bearing capacity is significantly improved. It is noted that a pile created in a drilled hole by placing mortar in the bore hole generally has a lesser bearing capacity than a driven pile, which supports in earth that is compressed as a result of the driving. A non-driven pile can be manufactured by applying the current invention, this pile having the advantages of the driven pile but not its drawbacks. The disadvantage of driving, such as noise and the shaking of surrounding building structures, is avoided if expanding mortar is cast in a bore hole, whereby the compression in the ground is realized as a result of expansion.

The additive substance can be so excessively dosed that the concrete condition becomes per se poor, and can even become so poor that the concrete mass injected into the ground falls apart as lumps. This has been found not to be a drawback per se, when this crumbled concrete mass has at least the bearing capacity of the surrounding soil type, and the bearing capacity of the surrounding soil type is improved. Since this earth is compressed because of the concrete injection, a significant improvement is already realized. It is otherwise easy using a crumbled expanding concrete mass to far surpass the bearing capacity of the surrounding earth. The required interior angle of friction of 35° is easy to realize for the expanded concrete, even in the case where for example 1200 kg. of additive is added per cubic metre of concrete mix in order to effect a linear expansion in the order of magnitude of 25%. The following abbreviations are used in the examples in the table following hereinafter:
PC-A Portland cement class A from ENCI in Maastricht;
CSA Calcium sulpho-aluminate of the brand "Dilacon" from Enichem Anic of Milan;
sand Netherlands moulding sand NEN 3550

composition (parts by mass)					free linear expansion %	expansion in ground at ground pressure %	ground pressure (M Pa)
PC-A	CSA	CaO	sand	water			
85	15	-	-	32	> 15	3	6
80	20	-	-	32	> 15	6.5	14
50	50	-	-	32	> 15	13	1.4
80	10	10	-	32	6	-	-
85	15	-	237	40	7	4.5	0.04
80	20	-	237	40	9	5	0.05
80	20	-	237	40	9	3.5	0.2
80	20	-	237	40	9	2	0.14
75	25	-	237	40	10	6	0.06
100	20	-	156	43	> 15	10	0.1
80	20	-	173	36	6	4	0.04

The expansion grout with constituents by mass PC-A : 50, CSA : 50 and water : 32 with considerable swelling is particularly applicable around the bottom end of a prefab concrete driven pile, whereby as a result of compressing of the ground a considerable friction force is applied to the pile.

Claims

1. Method for manufacturing a foundation, whereby expanding material is placed in the ground, characterized in that an expanding material is placed in the ground which has in the case of free expansion a linear expansion of at least 5%.

2. Method as claimed in claim 1, characterized in that expanding material is placed in the ground beneath an already existing foundation element.

3. Method as claimed in claim 1, characterized in that expanding material is placed in the ground and that thereafter a pile is driven into the ground into said expanding mass placed in the ground.

4. Method as claimed in claim 1, characterized in that a hollow is formed in the ground and that said hollow is filled with expanding material in order to form at least one piece of a foundation pile.

5. Method as claimed in any of the foregoing claims, characterized in that expanding material is employed which consists of a concrete mixture with so much additive substance that a linear expansion of at least 1% is achieved in compressed ground.

6. Method as claimed in claim 5, characterized in that at least 70 kg. of calcium sulpho-aluminate is added per cubic metre of concrete mortar.

7. Method as claimed in claim 5 or 6, characterized in that per cubic metre of concrete mortar a quantity of calcium sulpho-aluminate is added in the order of magnitude of 1000 kg.

8. Method as claimed in any of the foregoing claims, characterized in that an expanding concrete is used with a free linear expansion in the order of magnitude of 25%.

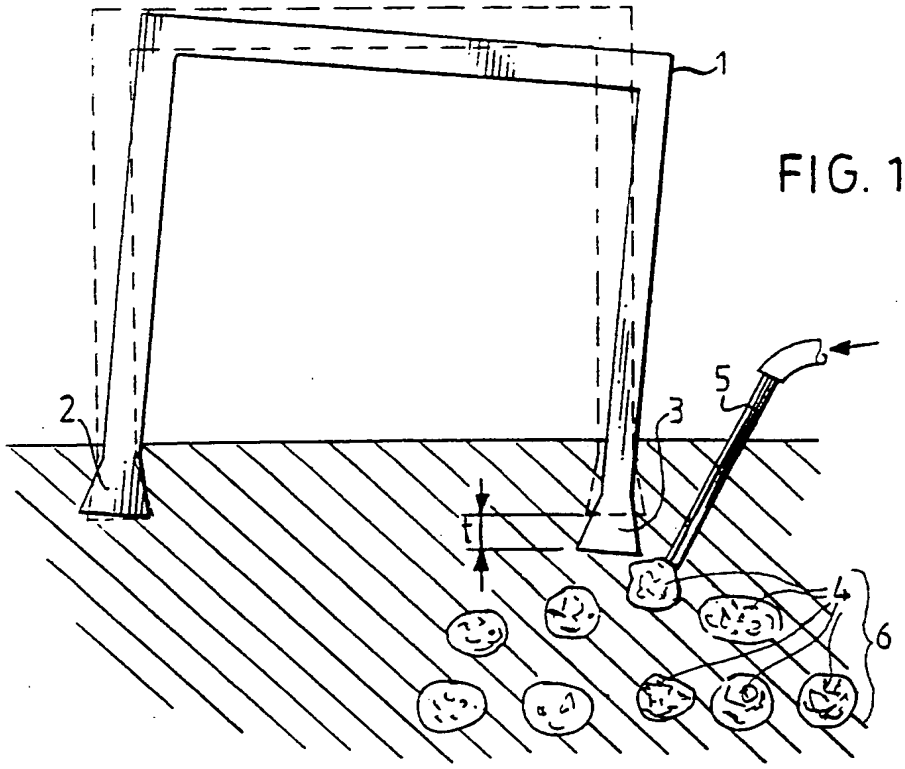


FIG. 1

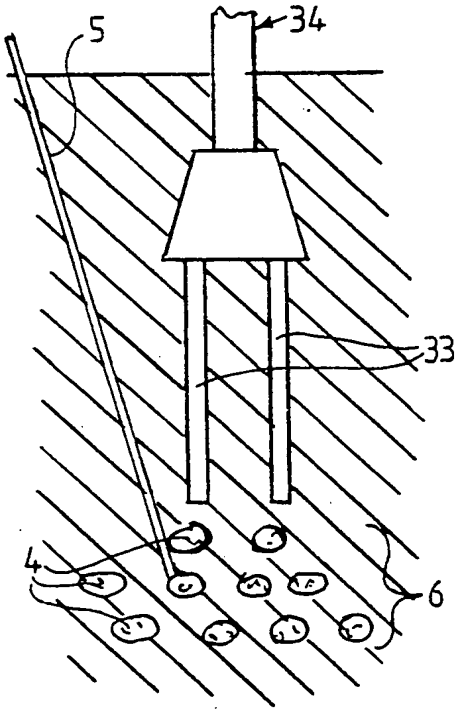


FIG. 2

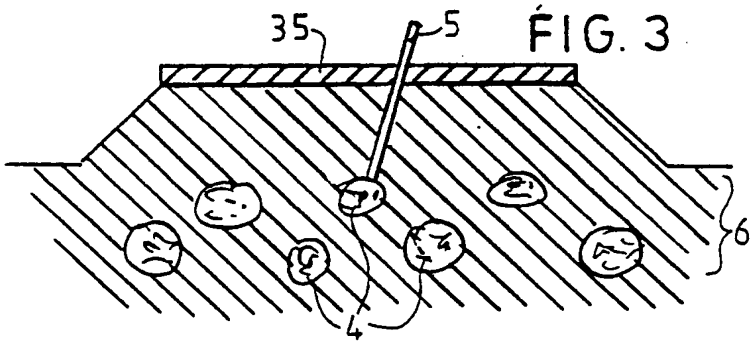


FIG. 3

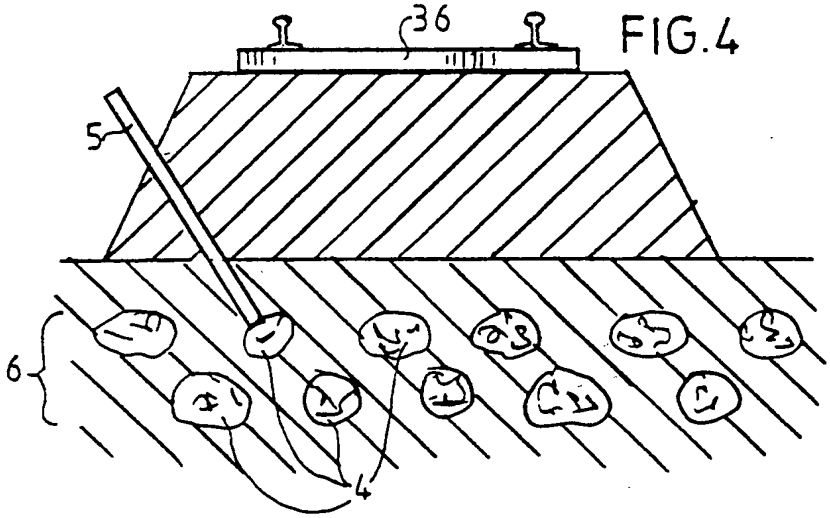


FIG.4

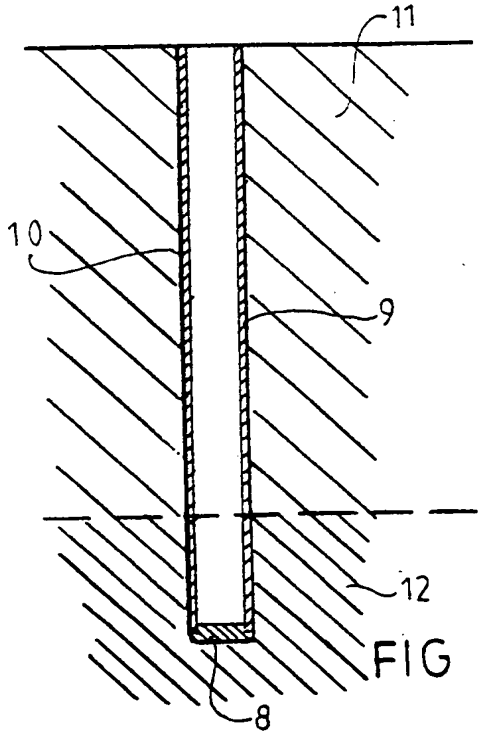


FIG 5a

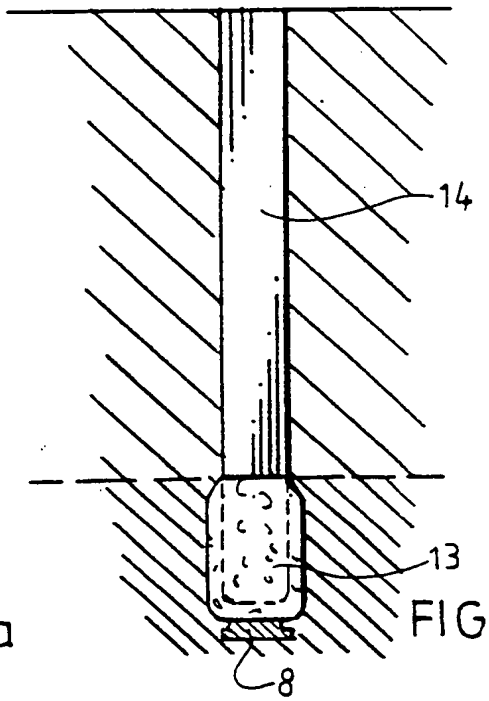


FIG 5b

FIG.6a

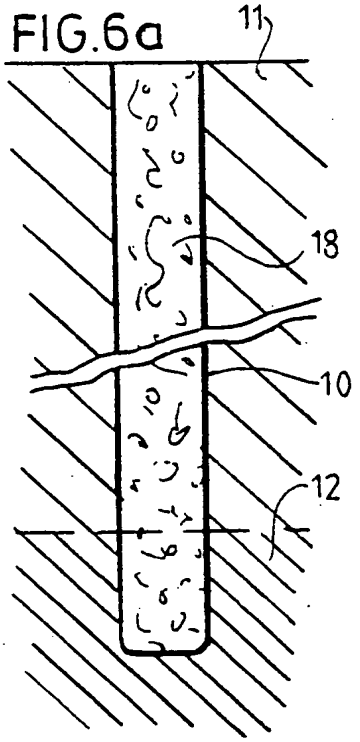
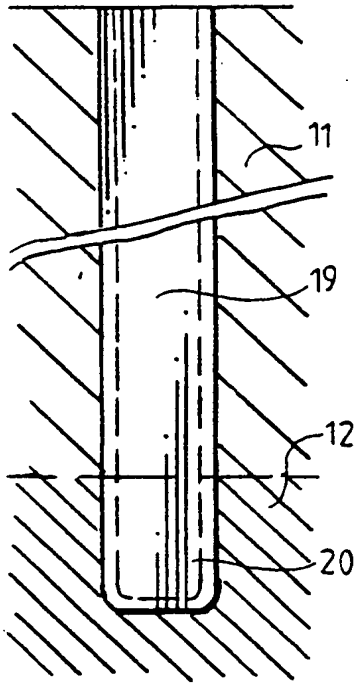


FIG. 6b



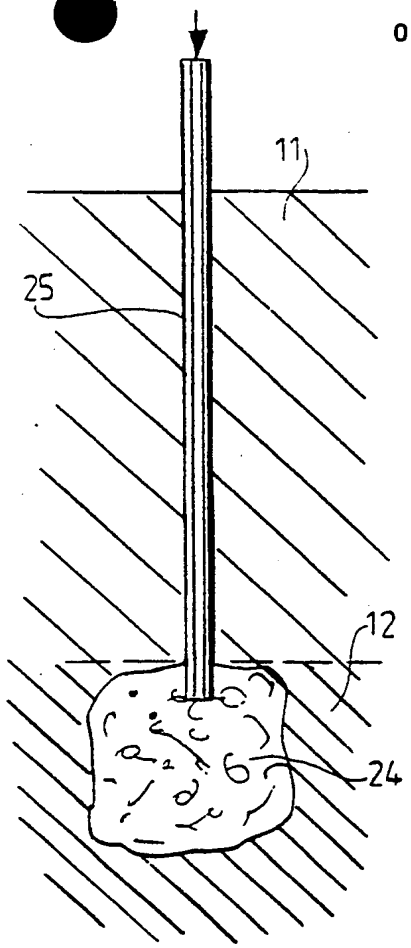


FIG. 7a

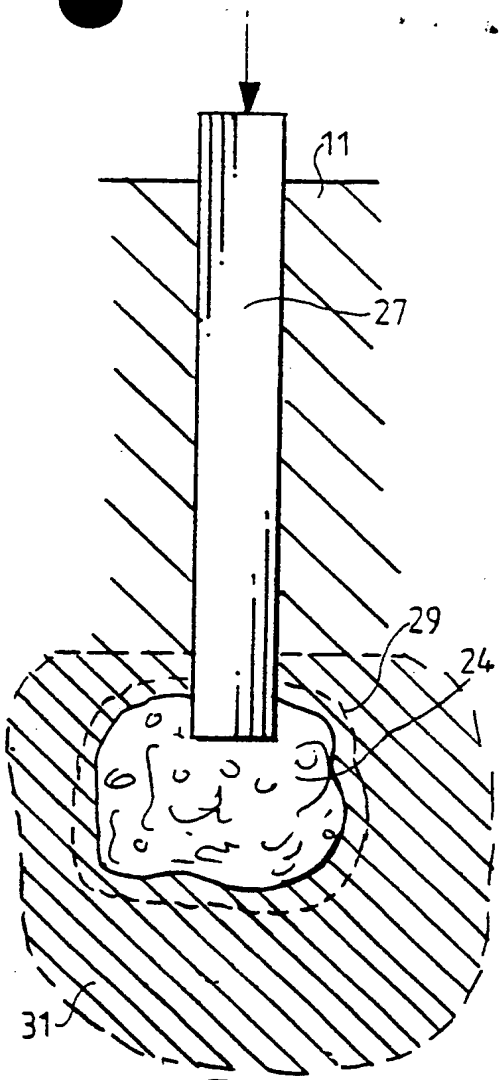


FIG. 7b

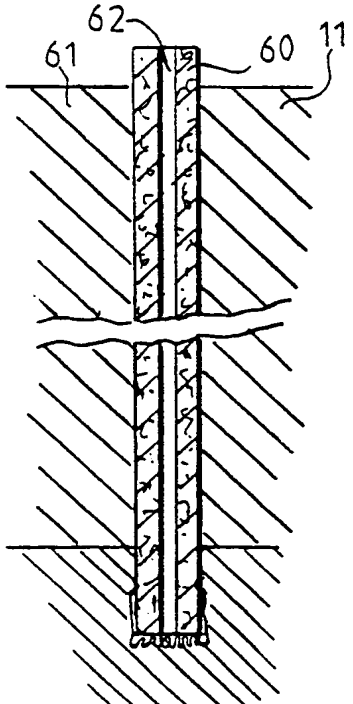


FIG. 8a

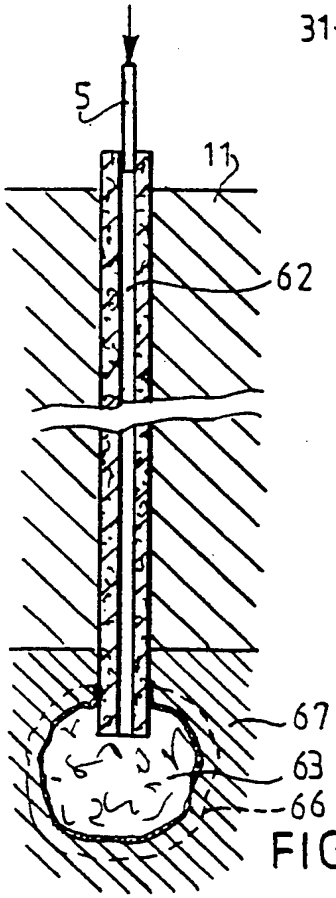
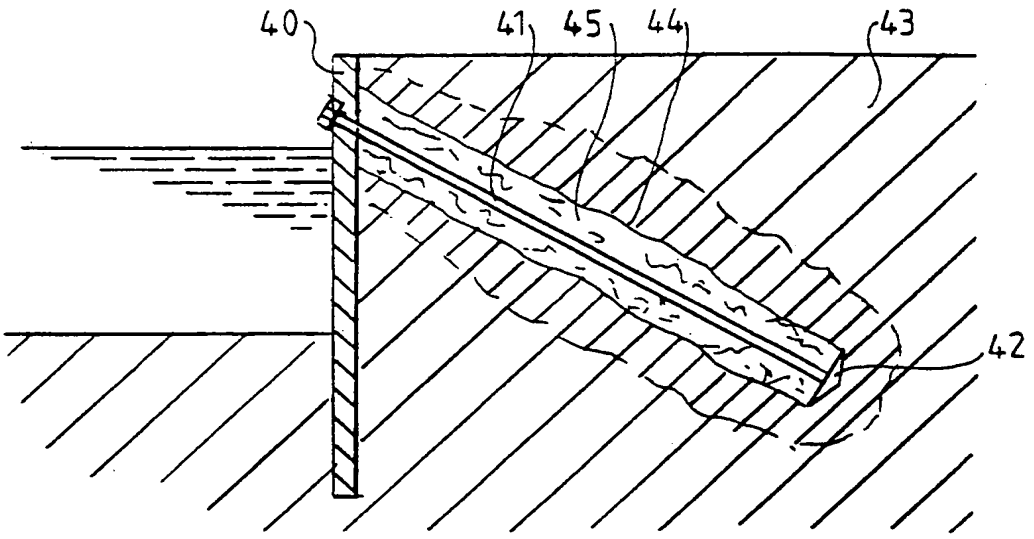


FIG. 8b

FIG.9



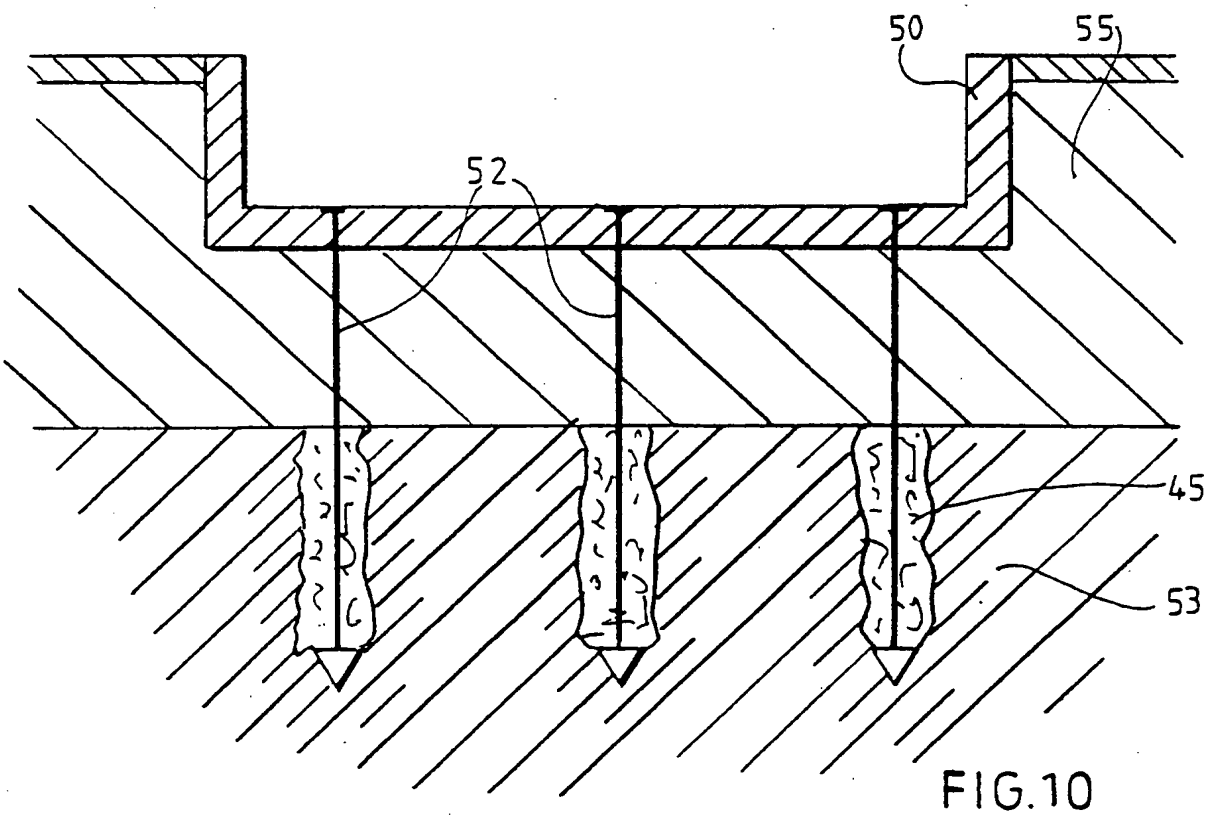


FIG.10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 20 1910

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-2 370 130 (NIPPON CONCRETE IND.) * Page 1, line 1 - page 5, line 18; figures 1-6 *	1,4,6	E 02 D 37/00 E 02 D 35/00
A	---	3,5,7,8	
A	FR-A-1 423 742 (SOLETANCHE) * Page 1, left-hand column, line 1 - right-hand column, line 38 *	2	
A	---		
A	US-A-4 567 708 (HAEKKINEN) * Column 2, line 63 - column 3, line 29; figure *	2	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

E 02 D
E 21 D
E 01 C
C 04 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12-01-1988	KERGUENO J.P.D.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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